In re Patent Application of:
CHAO-YANG HSU ET AL.
Serial No. **10/820,496**
Filing Date: **04/08/2004**

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In the Specification

[0002] For the line-interactive UPS (Uninterruptible Power Supply) system, there are generally three operation modes: on-line mode, back-up power ~~mold~~ mode and bypass mode. During the back-up ~~mold~~ mode, a battery will supply a voltage passing through an inverter to a load and the inverter will convert a DC voltage from the battery into an AC voltage. Please refer to Fig. 2, which illustrates a conventional charging circuit in the line-interactive UPS system. During a normal operation (on-line mode), a relay 101 or a switch is electrically conducted by a main power 102 electrically connected to output terminals 103 and 104 so as to directly output an AC voltage to a load (not shown). Then, when a controller detects an abnormal output of an AC line voltage, namely, the main power 102 is abnormal, the relay 101 or the switch will cut off the conduction thereof, and further, a battery 105 will provide a DC voltage, which can be converted into an AC voltage by an inverter 106. Therewith, the AC voltage is transformed by a transformer 107 for outputting.

[0004] However, because in this circuit the two switching devices Q1 and Q2 do not participate in the charging operation, the two switching devices Q3 and Q4 have to be controlled to be ~~conducted~~ conductive so that the transformer 107 can be shorted ~~in~~ for a specific duration for rapidly charging the leakage inductors of the transformer 107. When the conduction of the switching devices Q3 and Q4 is cut off, the leakage inductors will generate a maintaining current ~~for maintaining~~ and also charge the battery 105 through anti-parallel diodes. Therefore, according to the description above, it is obvious that the conventional line-interactive UPS

needs a complex circuit for realizing the purpose of current control.

[0005] In order to overcome the drawbacks in the prior art, a charging circuit in uninterruptible power supply system is provided. ~~Consequently, because of the technical defects described above, the applicant keeps on carving unflaggingly to develop a "charging circuit in uninterruptible power supply system" through wholehearted experience and research.~~

[0006] In accordance with one aspect of the present invention, a charging circuit in a back-up power system includes an output terminal electrically connected to a main power for providing an AC output voltage, a transformer having a secondary electrically connected to the output terminal, an electrical energy storage and supply device providing a DC current, an inverter having an ~~output end~~ output electrically connected to a primary of the transformer and an ~~input end~~ input electrically connected to the electrical energy storage and supply device and comprising four gate control switch devices to form a bridge switching device, wherein the four gate control switch devices each respectively have an anti-parallel diode, a first diode having an anode electrically connected to one output terminal of the bridge switching device, a second diode having an anode electrically connected to the other output terminal of the bridge switch device, and a charging switch device having a first conducting terminal electrically connected to a common cathode of the first and the second diodes and a second conducting terminal electrically connected to a negative electrode of the electrical energy storage and supply device so as to charge the electrical energy storage and supply device through one of a conduction state and a cut-off state of the charging switch device.

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[0009] Furthermore, the charging circuit further includes a fixed switch electrically connected between the main power and the output terminal for determining one of a conduction state and a cut-off state therebetween according to a control signal.

[0011] In accordance with another aspect of the present invention, a charging circuit in a back-up power system includes an output terminal electrically connected to a main power for providing therefrom an AC output voltage, a transformer having a secondary electrically connected to the output terminal, an electrical energy storage and supply device providing a DC voltage, an inverter having an ~~output end~~ output electrically connected to a primary of the transformer and an ~~input end~~ input electrically connected to the electrical energy storage and supply device and comprising four gate control switch devices to form a bridge switching device, wherein the gate control switch devices respectively have an anti-parallel diode, a bridge rectifier having an ~~input end~~ input electrically connected to the ~~output end~~ output of the inverter in parallel, and a charging switch device electrically connected to an ~~output end~~ output of the bridge rectifier in parallel so as to charge the electrical energy storage and supply device through one of a conduction state and a cut-off state of the charging switch device.

[0014] Furthermore, the charging circuit further includes a fixed switch electrically connected between the main power and the output terminal for determining one of a conduction state and a cut-off state therebetween according to a control signal.

[0023]Now, please refer to Fig. 2, which illustrates a schematic view of a charging circuit of a line-interactive UPS (Uninterruptible Power Supply) system in a first preferred embodiment according to the present invention. As shown in Fig. 2, a charging circuit in a line-interactive UPS system includes output terminals 203 and 204, a transformer 207, a battery 205, an inverter 206, a first diode D5, a second diode D6 and a charging switch device Q5. The output terminals 203 and 204 are electrically connected to a main power 202 for providing an AC output voltage, a secondary of the transformer 207 is electrically connected to the output terminals 203 and 204 and the battery 205 is employed to provide a DC voltage. Moreover, an ~~output end~~ output of the inverter 206 is electrically connected to a primary of the transformer 207 and an ~~input end~~ input thereof is electrically connected to the battery 205, and the inverter 206 includes four gate control switch devices Q1, Q2, Q3, Q4 to form a bridge switching device, wherein the four gate control switch devices Q1, Q2, Q3, Q4 respectively have an anti-parallel diode D1, D2, D3, D4. Furthermore, an anode of the first diode D5 is electrically connected to one ~~output end~~ output of the bridge switching device and an anode of a second diode D6 is electrically connected to the other ~~output end~~ output of the bridge switch device. Then, ~~a first conducting end~~ the drain of the charging switch device Q5 is electrically connected to a common cathode of the first and the second diodes D5, D6 and ~~a second conducting end~~ the source thereof is electrically connected to a negative electrode of the battery 205 so that the charge of the battery 205 can be controlled through one of a conduction state and a cut-off state of the charging switch device Q5.

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[0024]Meanwhile, each of the gate control switch device can be a power MOSFET and each of the anti-parallel diode can be an intrinsic anti-parallel diode of the power MOSFET. And, the charging circuit in the line-interactive UPS can further include a fixed switch 201 to be connected between the main power 202 and the output terminal 203 for determining a conduction state or a cut-off state therebetween according to a control signal.

[0026] When the line-interactive UPS system is normally provided by a utility electricity, the operation principle of the charging circuit is described as follows. ~~:~~

[0027] When the charging switch device Q5 is ~~conducted~~ conductive during a positive half cycle of the main power 202, the first diode D5 and the anti-parallel diode D3 are ~~conducted~~ conductive, ~~for~~ thus shorting the transformer 207 ~~in~~ for a specific duration so as to charge the leakage inductor 208 of the transformer 207. When the conduction of the charging switch device Q5 is cut off, the leakage inductor 208 will generate a current for maintaining a continuous current flow to charge the battery 205 through the anti-parallel diodes D2, D3.

[0028] When the charging switch device Q5 is ~~conducted~~ conductive during a negative half cycle of the main power 202, the second diode D6 and the anti-parallel diode D4 are ~~conducted~~ conductive, ~~for~~ thus shorting the transformer 207 ~~in~~ for a specific duration so as to charge the leakage inductor 208 of the transformer 207. When the conduction of the charging switch device Q5 is cut off, the leakage inductor 208 will generate a current for maintaining a continuous current flow to charge the battery 205 through the anti-parallel diodes D1, D4.

[0029] In this preferred embodiment, a value of the current limiting resistor R1 can be easily ~~designed~~ selected to limit the magnitude of the charging current.

[0030] Please refer to Fig. 3, which illustrates a schematic view of a charging circuit of a line-interactive UPS (Uninterruptible Power Supply) system in a second preferred embodiment according to the present invention. As shown in Fig. 3, a charging circuit in a line-interactive UPS system includes output terminals 303 and 304, a transformer 307, a battery 305, an inverter 306, a bridge rectifier 309 and a charging switch device Q5. The output terminals 303 and 304 are electrically connected to a main power 302 for providing an AC output voltage, a secondary of the transformer 307 is electrically connected to the output terminals 303 and 304 and the battery 305 is employed to provide a D C voltage. Moreover, an ~~output end~~ output of the inverter 306 is electrically connected to a primary of the transformer 307 and an ~~input end~~ input thereof is electrically connected to the battery 305, and the inverter 306 includes four gate control switch devices Q1, Q2, Q3, Q4 to form a bridge switching device, wherein the four gate control switch devices Q1, Q2, Q3, Q4 respectively have an anti-parallel diode D1, D2, D3, D4. Furthermore, an ~~input end~~ input of the bridge rectifier 309 is electrically connected to the ~~output end~~ output of the inverter 306 in parallel, and the charging switch device Q5 is electrically connected to an ~~output end~~ output of the bridge rectifier 309 in parallel so that the charge of the battery 305 can be controlled through a conduction and a cut-off of the charging switch device Q5. Meanwhile, each gate control switch device Q1, Q2, Q3, Q4 can be a power MOSFET and each anti-parallel diode D1, D2, D3, D4 can be an intrinsic anti-parallel diode of the power MOSFET. And, the charging circuit in the line-interactive UPS system can further include a fixed switch 301 to be connected between the main power 302 and the

output terminal 303 for determining a conduction state or a cut-off state therebetween according to a control signal.

[0031] When the line-interactive UPS system is normally provided by a utility electricity, the operation principle of the charging circuit is described as follows. ~~:~~

[0032]When the charging switch device Q5 is ~~conducted~~ conductive during a positive half cycle of the main power 302, the diodes D7 and D8 of the bridge rectifier 309 are ~~conducted~~ conductive, ~~for~~ thus shorting the transformer 307 ~~in~~ for a specific duration so as to charge the leakage inductor 308 of the transformer 307. When the conduction of the charging switch device Q5 is cut off, the leakage inductor 308 will generate a current for maintaining a continuous current flow to charge the battery 305 through the anti-parallel diodes D2, D3.

[0033] When the charging switch device Q5 is ~~conducted~~ conductive during a negative half cycle of the main power 302, the diodes D6 and D9 of the bridge rectifier 309 are ~~conducted~~ conductive, ~~for~~ thus shorting the transformer 307 ~~in~~ for a specific duration so as to charge the leakage inductor 308 of the transformer 307. When the conduction of the charging switch device Q5 is cut off, the leakage inductor 308 will generate a current for maintaining a continuous current flow to charge the battery 305 through the anti-parallel diodes D1, D4.